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ABSTRACT

The ability of 120 children (mean ages 6.2, 8.2, 10.1, and 12.3) to perform discrimination learning and subsequent transposition tasks was observed utilizing three experimental conditions (overt-verbal, covert-verbal, and control). The performance of the subjects suggests that the child who is forced to verbalize his conceptual strategies will reach criterion faster in the discrimination learning task and will also be more successful in his attempts to transpose. With regard to transposition specifically, it was found that overt-verbal learning was significantly more effective than covert-verbal learning, and that the covert-verbal condition yielded significantly higher scores than did the control (non-forced) condition. These results point to the effectiveness of verbal mediation in the transfer of learning. (Author)

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Effects of Verbalization and Age on Discrimination Learning and Transposition

A central, but unresolved question in language-cognition research has been the direction of influence. That is, does language merely reflect development in cognitive skills (a Piagetian position), or does language influence the direction and type of cognitive development (the Soviet position a la Vygotsky and Luria)? Without claiming hardfast directionality, it appears that one can at least make a case for the mediational influence of language on concept learning.

> As language becomes more internalized, more guiding as a set of rules for organizing events, there is a shift from the associative principles that operate in classical perceptual organization to the increasingly abstract rules for grouping events by the principles of inclusion, exclusion, and overlap, the most basic characteristics of any hierarchical system.[1]

The focus of this study will be to analyze the role of verbalization as it affects concept acquisition and utilization. Hence, language will be treated as an independent variable while conceptual behavior will be viewed as the dependent measure.

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Specific questions concerning the role of verbalization as a symbolic mediator have been raised by a number of researchers concerned with such performance criteria as discrimination learning, problem-solving and transposition. Kendler[2] found that requiring kindergarten subjects to label problem relations verbally facilitated initial learning and increased the proportion of subjects making a subsequent optional reversal shift (a shift to another relevant dimension). Weir and Stevenson[3] tested not only the effects of verbalization of the stimulus before the accompanying response, but also the effect of chronological age on learning. Verbalization was found to be instrumental at all ages (three, five, seven, nine), but learning speed did not increase with age. Wilder[4] found that spoken rehearsal was superior to silent rehearsal in learning to discriminate. With regard to transposition behavior, Darnell and Bourne[5] concluded that high verbal-ability subjects functioned better than low verbal-ability subjects in classification tasks.

Given that the findings have been relatively inconsistent, that performance measures are not easily comparable, and that verbalization has not been strictly defined in a transposition context, it seems appropriate to construct a test designed to include the following: (a) a strict operationalization of verbalization as the independent variable; (b) subjects of varying ages to test the effect of age on concept learning and utilization; (c) a two-part test which could operate as a self-contained concept acquisition and application situation. The following hypotheses are outlined below as they relate to the two-step conceptual behavior task.

METHOD

Discrimination Learning

Discrimination learning involves the identification of dimensions which the experimenter deems as relevant. Examples of possible dimensions are size, color and shape. In the present experiment, there were two relevant dimensions to be learned and identified, both dealing with spatial arrangements of the stimulus objects. The subject learned to respond correctly to the relevant and irrelevant dimensions by receiving feedback to his response on the learning trials. The efficiency of this learning procedure was indexed by the number of trials to criterion.

Hypothesis 1: Trials to criterion will decrease with increasing age. This is simply to say that the subject's efficiency in dealing with new information should improve as he matures.

Hypothesis 2: Efficiency in reaching criterion, as measured in number of trials, will be of the order Vo > Vc > C. In other words, it is believed that requiring the subject to voice his strategy aloud will aid in his learning of the relevant dimensions of the task in fewer trials than saying it only to himself (covert) or not at all (control), and that covert "voicing" will be more efficient than non-forced voicing.

Hypothesis 3: There will be an interaction between verbal conditions and age levels on the number of trials taken to criterion. On the basis of existing mediation research, one would expect the younger children to be more positively affected by having to overtly and covertly verbalize their answers than older subjects.

The Transposition Task

The transposition task is basically a transfer of training problem, in which the subject is required to generalize the strategies he has acquired in the discrimination learning task to another context. In the present case, the subject was asked to construct three spatial designs (using geometric shapes) on the basis of what he had learned earlier in the discrimination learning task. In general, it was predicted that the type of verbal condition and age would largely determine his ability to transpose, i.e., to reproduce analogous spatial relationships.

Hypothesis 4: The ability to transpose will increase with age.

Hypothesis 5: The effect of verbal conditions in terms of transposition successes will be of the order Vo>Vc>C.

Hypothesis 6: There will be an interaction between verbal conditions and age levels on the transposition tasks.

Personnel

Six experimenters were hired to administer the two experimental tasks. All were female, of approximately the same age, and were trained prior to the testing to achieve uniformity in their giving of instructions and feedback. During the period of actual testing, periodic meetings were arranged in an attempt to curb procedural variation among the experimenters. As far as possible, each experimenter was assigned to an equal number of subjects in each condition.

Subjects

One hundred and twenty students enrolled in grades kindergarten, second, fourth, and sixth at Lake View Elementary School in Solon, Iowa, participated

in the study. After selecting thirty children from each grade level, four age conditions were established with mean ages 6.2, 8.2, 10.1, and 12.3 respectively. Subjects from each of these age groups were randomly assigned to three verbal conditions. The only requirement for participation was that the child enter into the experiment voluntarily.

Specific Procedure

In task A (discrimination learning) each subject was shown sixteen 5 x 8 cards, one at a time. Each card portrayed a different arrangement of geometric shapes of a chosen color. These shapes were described to the subject as people in a group who are in some way related and perhaps capable of performing an unspecified task. "On each of these cards is a group of objects; each object represents a person who is part of this group. Your task is to tell me which groups are able to do the job I have in mind, and which cannot." Following these preliminary directions, the subject was shown a card, to which he responded "yes" or "no" in answer to the experimenter's question, "Is this group able to do the job?"

The period immediately following the presentation of each card and the subject's subsequent response was different for each of the verbal conditions. In the overt verbal condition (Vo), the subject was told whether his response was "correct" or "incorrect," and was then asked to verbalize the reason why he gave that particular answer.

In the covert verbalization condition (Vc) the subject was required to say to himself the strategy he employed in making his decision. "After you see the card and say whether it is right or wrong, i.e., say whether or not the group can do the job, I will tell you that you are either correct or

incorrect. You are then to say to yourself why it was you gave that answer." In the control condition (C) the subject was required to respond only "yes" or "no" after the presentation of each card, and one in which the experimenter replied only "correct" or "incorrect." Nothing was said to the subject concerning the reasons for his response.

After each trial, or run through the sixteen cards, the deck was shuffled to prevent the subject from learning on the basis of order of presentation. The criterion was set at two perfect runs through the deck in succession. In effect, each subject learned which cards (or stimulus patterns) were correct in this situation and which were not. If a subject learned to discriminate only on the basis of perceptual memorization without a transferable, abstract rule or principle, one would expect little generalization to an analogous task--in this case the three transposition problems described below. In addition, if any subject went for a half hour without learning the task, he was released and another subject was called to take his place. Since it was essential that every subject reach criterion for the purposes of the subsequent transposition task, and because the number of "non-learners" replaced by "learners" varied in no significant was with regard to verbal and age groups, this decision was believed justified.

In task B (transposition) subjects were in essence required to transfer the rules or principles acquired on task A (discrimination learning) to a different, but analogous context. Directly after reaching criterion on task A, i.e., after responding correctly to a run of sixteen stimulus cards twice in succession, the subject was led to a table in the same room, upon which was placed a sheet of white mat board 3 x 4½ feet in size. This particular

surface was used to insure presentational consistency among experimenters, and to provide a smooth, uniform surface upon which the subjects could perform the three transposition problems.

The subject was handed a cluster of six, 2 inch by 3 inch geometric shapes of a uniform color different from those used in the discrimination learning task (in the present case orange eight-sided figures). The subject was then instructed to "make a group of people who are able to do the same job as those in the task before this one." Following the subject's successful or unsuccessful attempt to distribute the figures properly, he was asked again--this time with another group of objects with different color and shape characteristics (blue triangles)--to make yet an additional group that "can do the job." This completed, the procedure was repeated a third and final time with objects of a different color and shape (brown rhomboids). The potential score for each subject thus ranged from 0 to 3.

The Design

The design of the experiment was a basic 4 x 3 factorial. The four age conditions were represented by mean ages 6.2, 8.2, 10.1 and 12.3. The verbal conditions were comprised of the overt verbal condition (Vo), the covert verbal condition (Vc), and the control condition (C). The discrimination task, as mentioned above, was measured in terms of trials to criterion. This dependent measure constitutes a discrete index which is amenable to an analysis of variance. Treatment of the transposition data which were coded 0, 1, 2, or 3 also employed analysis of variance. Finally, Duncan's test of multiple comparisons was used as a follow-up technique in locating significant differences between cell means. All levels of significance were set at the .05 level.

RESULTS

Analysis of Variance: Trials to criterion on Discrimination Learning

Hypothesis 1, which stated that increasing age will decrease the number of trials needed to reach criterion was not supported ($F=.371$/ $p>.05$). It appears the older subjects had no advantage in learning a task which was largely perceptual in nature. While somewhat surprising, this finding can perhaps be explained if one considers the extent to which perceptual props figure in early learning. Younger subjects had little difficulty with straightforward perceptual problems, but as will be discussed below, had considerable trouble with a more abstract level of problem-solving.

Verbal conditions did yield an overall significant F-ratio ($F=3.69$/ $p<.05$). That is, the ability to reach criterion was in some way dependent on the nature of the verbal condition, i.e., overt, covert or control. To determine precisely where the differences within conditions lay, Duncan's test of multiple comparisons was used. Shown below are the mean number of trials needed to reach criterion. The lower the mean, the fewer the trials needed to successfully complete the task.

	Covert 7.15	Control 8.17
Overt (3.57)	1.78*	2.80*
Govert (7.15)	--	1.02

*Significant at the .05 level

It appears that the overt verbal condition was more effective in allowing the subjects to reach criterion in fewer trials were either the covert

verbal or control conditions. This finding at least partially, substantiates Hypothesis 2, which stated that effectiveness will be of the order Vo>Vc>C. Hypothesis 3, which predicted an interaction between age and verbal conditions was not confirmed ($F=2.01/ p>.05$).

Analysis of Variance: Success on the Transposition Tasks

Hypothesis 4 stated that increasing age will assist the subjects in successfully completing the transposition problems. The obtained F-ratio indicated an effect of age on transposition success ($F=4.66/ p<.05$). The multiple comparisons test shown below indicates the mean difference in the number of correct attempts per cell.

	2 1.76	4 1.76	6 2.36
K (1.20)	.56	.56	1.16*
2 (1.76)	--	.00	.60
4 (1.76)	.00	--	.60

*Significant at the .05 level

Perhaps the most interesting of all the hypotheses is that concerned with the effect of the verbal conditions on the subjects' ability to transfer learning principles to other contexts. An F-ratio of 9.46 ($p<.05$) within verbal conditions indicated that, indeed, significant differences did exist. However, no interaction between age and verbalization occurred thus lending no support to Hypothesis 8.

Below are listed the comparisons of the mean number of successes on the three transposition tasks. A higher cell average indicates a larger number of succeses.

	Covert 1.80	Overt 2.35
Control (1.17)	.63*	1.18*
Covert (1.80)	--	.55*

*Significant at the .05 level

Not only was the overt verbal condition distinctly more effective than both the covert verbal and control conditions, but in addition, the covert verbal proved to be significantly more effective in assisting transposition than the control condition.

DISCUSSION

While age appears to have made little difference with regard to these specific tasks, the effects of the verbal conditions were noticeable. Requiring subjects to state the principles they were using in learning the relevant dimensions allowed them to reach criterion faster than those subjects in the covert verbal and control groups. Rather than simply responding to a stimulus, such as a pattern card, being required to verbalize a strategy added a component to the S-R chain, i.e., S-r-s-R.[6] Unfortunately, exactly how this additional component functions is an unsettled question. At the simplest explanatory level, one might claim that requiring the subject to deliberate longer by verbalizing functions to make him consider his responses more carefully and strengthens the processes of memory. However, it seems more plausible to contend that language as an abstract mediating device allows the subject to generalize across differing situations with relative ease. In short, language is effective both in learning and transforming rules.

Just why overt verbalizing should be more effective than covert verbalizing in reaching criterion requires an explanation which has yet to appear in theoretical form. Perhaps auditory feedback functions to enhance the effectiveness of mediation. It is also possible that the children at some age levels could not comprehend the instructions to verbalize covertly, or were simply unable to carry out instructions of this type. However, this explanation seems unlikely because covert verbalization had a significantly different effect on transposition successes than did the undirected behavior of the control group. Perhaps a more reasonable explanation is that despite intermittent reminding, subjects in the covert condition simply represent an average between overt and control conditions. That is, children verbalized and some did not, and the obtained scores constitute this average.

As mentioned above, transposition is probably the most interesting and potentially revealing of the experimental tasks. It was during the transpositional phase of the experiment that the child was forced to consider what he had learned, and to apply this to a new, but related context. More important than the significant effect of age were the effects of the two verbalization conditions and the one control condition. The fact that the overt mode was more effective than covert or control conditions, while covert was more effective than control, is intuitively reasonable but difficult to place in a theoretical context. It does appear, however, that conceiving of language as a mediator between the environment and thought processes serves very nicely to explain the superior ability of the verbal subjects to transpose. The acquisition of a learning principle rather than a concrete perceptual image was facilitated by the process of verbalization. This, in turn, led to greater success in the transfer of training.

FOOTNOTES

[1]Bruner, Jerome S., "The Course of Cognitive Growth," American Psychologist, XIX (1964), pp. 1-14.

[2]Kendler, T. S., "Verbalization and Optimal Reversal Shift Among Kindergarten Children," Journal of Verbal Learning and Verbal Behavior, III (1964), pp. 428-436.

[3]Weir, Morton W. and Harold W. Stevenson, "The Effect of Verbalization in Children's Learning as a Function of Chronological Age," Child Development, XXX (1959), pp. 143-149.

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[5]Darnell, D. D. and L. E. Bourne, Jr., "Effects of Age, Verbal Ability, and Pretraining with Component Concepts on the Performance of Children in a Bi-dimensional Classification Task," Journal of Educational Psychology, LXVIII (1970), pp. 66-71.

[6]Kendler, T. S., "An Ontogeny of Mediational Deficiency," Child Development, XLIII (1972), pp. 1-17.

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